

PROJECT facts

Environmental & Water
Resources

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U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY



SORBENT INJECTION FOR SMALL ESP MERCURY CONTROL IN LOW SULFUR EASTERN BITUMINOUS COAL FLUE GAS

CONTACTS

Thomas J. Feeley III

Technology Manager
Environmental & Water Resources
412-386-6134
thomas.feeley@netl.doe.gov

Dawn Marie Deel

Project Manager
304-285-4133
dawn.deel@netl.doe.gov

PARTNERS

URS Group;

Austin, TX

Southern Company Services inc.

Newnan, GA



Description

Objective

This project was designed to generate data to show the economic benefits of sorbent injection for mercury control in a bituminous coal environment with an electrostatic precipitator (ESP) or ESP/flue gas desulfurization (FGD) configuration. Using low-cost sorbents, the project generated data for use in an economic analysis of the costs associated with full-scale implementation of a sorbent-based injection system for these types of facilities. This project tested full-scale sorbent injection on a short-term basis at Georgia Power's Plant Yates Unit 1 and Unit 2. Unit 1 was also tested on a long-term basis. The goals of the long-term testing were to obtain sufficient operational data on: 1) removal efficiency over time, 2) effects on the ESP and balance of plant equipment, and 3) injection equipment operation to prove process viability.

Background

EPRI, DOE, and EPA have undertaken extensive R&D programs over the past decade to develop cost-effective methods for reducing mercury emissions from coal-burning power plants. Many of these programs were collaborative efforts designed to understand the factors that affect the properties of mercury emissions in flue gas streams, but then progressed to studies of the flue gas parameters that controlled the effectiveness of promising control processes such as activated carbon injection (ACI). Under most conditions, if carbon achieves good contact with gaseous mercury for a sufficient amount of time, it will adsorb mercury. The resulting mercury-laden carbon is then collected by downstream particulate control. Both pilot and full-scale injection systems have been tested with various sorbents and with combinations of fuel and plant air pollution control devices. These pilot- and full-scale test programs have provided a good understanding of variables that affect the performance of sorbent injection systems.

Summary

Various carbon-based sorbents were injected upstream of low Specific Collecting Area (SCA) ESP systems at Georgia Power's Plant Yates Units 1 and 2 in Newnan, GA. Both Units 1 and 2 fire a low sulfur Eastern bituminous coal. Unit 1 is equipped with a jet bubbler reactor (JBR) wet FGD system downstream of the ESP for SO₂ control. Unit 2 is not equipped with downstream SO₂ controls; however, a dual flue gas conditioning system is used to enhance ESP performance.

COST

Total Project Value

\$1,183,656

DOE/Non-DOE Share

\$858,004 / \$325,652

PERIOD OF PERFORMANCE

September 2003 to
September 2005

ADDRESS

National Energy Technology Laboratory

626 Cochran's Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

One West Third Street, Suite 1400
Tulsa, OK 74103-3519
918-699-2000

539 Duckering Bldg./UAF Campus
P.O. Box 750172
Fairbanks, AK 99775-0172
907-452-2559

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Short-term parametric tests were conducted on Units 1 and 2 to evaluate the performance of activated carbon sorbents. In addition, the effects of the dual flue gas conditioning system on mercury removal performance were evaluated as part of the short-term parametric test on Unit 2. Based on the results of the parametric tests, a single sorbent was selected for longer-term full-scale tests on Unit 1 to observe long-term performance of the sorbent as well as its effects on ESP and JBR FGD system operations and combustion byproduct properties. The results of this study provided data required for assessing the performance and long-term operational impacts as well as for estimating the costs of full-scale sorbent injection processes for flue gas mercury removal.

Conclusions

- Norit America's Darco FGD™ carbon, RWE Rheinbraun Super HOK, and Ningxia Huahui (NH) Carbon were the three sorbent materials selected for ACI testing on Unit 1. Super HOK carbon was also selected for the long-term injection test, because of it's comparable performance and lower cost compared to Norit America's Darco FGD™. Most of the test conducted at carbon injection rates between 4 and 10 lb/MMacf. Performance curves are shown below.
- For the short-term tests (<10 days continuous injection) tests on Unit 1, removal of total vapor-phase mercury leveled off at approximately 70-80% for the combined ESP/FGD system at an injection rate of approximately 3 lb/MMacf and little additional removal of total mercury was observed at higher injection rates. No measurable impact was evident on ESP performance, even at high carbon injection rates.
- For Unit 2, parametric tests showed that injection of the benchmark Darco FGD activated carbon upstream of the ESP resulted in total vapor-phase mercury removals in the 43-73% range, at injection rates ranging from 2.3 to 12.7 lb/MMacf. The removal curve was relatively flat at about 70% for injection rates greater than approximately 6 lb/MMacf.
- For long-term testing, mercury removal across the ESP was in the 50-91% range, with most data concentrated between 60 and 85%. The mercury removal across the ESP/FGD scrubber system ranged from 50 to 97%, with most data concentrated between 70 and 94%. Baseline (no injection) mercury removals were 50% across the ESP and 80% across the system.

Planned Activities

Complete overall data analysis, economic analysis, and final report.

